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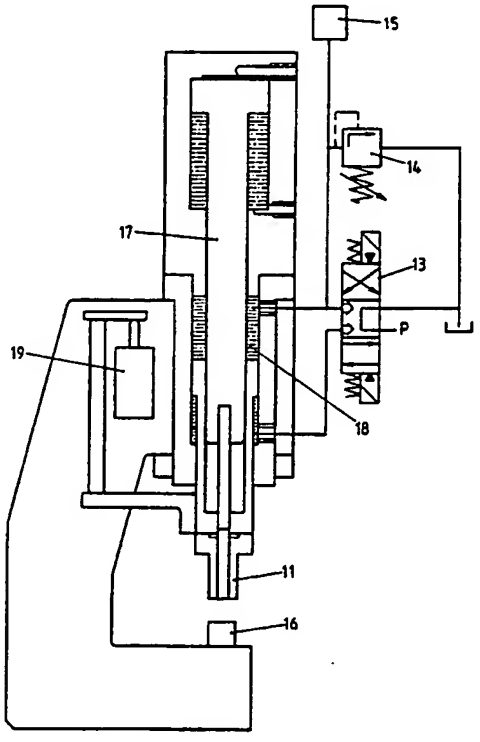
(54) Title: FASTENER APPLICATOR WITH INDEPENDENT WORKPIECE CLAMPING AND FASTENER DRIVING

(57) Abstract

A fastener applicator, for hollow self-piercing rivets, incorporates independent fluid actuators for a workpiece contact and clamping nose assembly (11) and a fastener drive plunger (17), whereby the workpiece clamping forces can be controlled independently of the fastener application.



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Fastener Applicator with Independent Workpiece Clamping and Fastener Driving

Technical Field

This invention relates to the application of fasteners, such as self-piercing rivets, to a workpiece and in particularly concerned with a fastener applicator workpiece contact nose assembly.

The term "self-piercing" is used to embrace hollow, eg tubular, or part-tubular, rivets which can be used to fasten together two or more workpiece elements, such as sheets of material, without the need for a preformed hole or holes in the material.

Background Art

In a known form of fastener applicator, such as for self-piercing rivets, a workpiece contact nose is spring-loaded onto a reciprocating fastener drive plunger, so that, as the plunger moves towards a workpiece, it carries the nose with it.

When the travel of the nose is arrested by workpiece contact, the plunger continues to move and apply progressively increasing spring pressure to the nose, thereby clamping the workpiece between the nose and the die as it inserts a fastener into the workpiece.

When the plunger has completed its fastener driving stroke, it moves away from the workpiece, but the nose remains in workpiece contact, until the spring has reverted to its relaxed condition, upon which it moves away with the plunger.

In order to inhibit fastener mis-application, the travel of the nose is often used as a means of determining the workpiece thickness, or to monitor applicator position correctness.

Thus, errors in either workpiece thickness or position generate an abort signal to inhibit fastener application.

This mode of operation has various attendant disadvantages.

1. The required clamping force is often greater than can be provided by a mechanical spring housed in the limited space available within an applicator.

2. Furthermore the requirement is often for a high initial nose clamping force, progressively reduced as the fastener is applied, and this force variability profile cannot be achieved by a spring-operated system;

3. The clamping forces required frequently differ from one fastening point to another within any one workpiece assembly, and a spring-operated system cannot readily be programmed to meet this requirement;

4. With the nose assembly spring-loaded onto the main plunger assembly, all its movements are necessarily relative to those of the plunger. Hence it is almost impossible to hold the nose in a fixed position relative to the die when the plunger is moving. Even when the plunger is at rest, any error in its positioning is automatically transmitted to the nose;

5. The time delay between the end of the fastener application stroke and the moment when the applicator is free to move to the next fastening operation is necessarily greater if the nose remains in contact with the workpiece during the initial retraction of the plunger;

6. The main plunger assembly has to be triggered to bring the nose into contact with the workpiece, and consequently there are severe problems under high speed operation in aborting the application cycle, should this be necessary, before the fastener has entered the workpiece.

Moreover, generally it is undesirable to allow a fastener, such as a rivet, to force workpiece elements together prior to fastening them.

With hitherto known spring-loaded fastener applicator nose clamping the spring must not be allowed to go solid and the typical maximum clamping force which can thereby be applied is about 30 lbs.

Should this be insufficient to bring the workpiece elements together, the residual bringing together and clamping action has to be provided by the act of closing the rivet itself.

This is problematical because the workpiece elements do not necessarily come together without some component of sideways movement sufficient to draw the rivet off-line, resulting in a faulty rivet fastening set.

Disclosure of Invention

The present invention provides a fastener applicator comprising a nose movable by nose drive means to contact a workpiece to which fasteners are to be applied, a plunger movable independently of the nose drive means by plunger drive means, to apply a fastener to the workpiece through the nose and nose control means for the nose drive means to bring the nose into workpiece contact and to control the contact forces applied by the nose to the workpiece.

Such an applicator overcomes the aforesaid disadvantages of known mechanical spring-loaded clamping nose assemblies.

More specifically, by incorporating a fluid, eg hydraulic or pneumatic, cylinder to the nose assembly and controlling the flow of fluid to and from this cylinder by means of appropriate valves, the precise movements and clamping forces required for any application can be generated.

Thus, in practice, the nose drive means preferably comprises a dedicated fluid actuator and the nose control means comprises a fluid pressure relief valve operable to control

the actuator working pressure.

Description of Embodiments

There now follows a description of some particular embodiments of the invention, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a fastener applicator with dual co-operating fluid actuators for a workpiece contact nose and fastener drive plunger; and

Figure 2 shows a double-acting fluid actuator variant of the fastener applicator shown in Figure 1.

Referring to the drawings, in particular Figure 1, a fastener applicator of a general 'C'-frame configuration 20 incorporates a workpiece contact and clamping nose assembly 11 actuated by a dedicated nose drive, in turn comprising a hydraulic cylinder 12 supplied from a high pressure source through a solenoid valve 13.

The nose assembly 11 is hollow allowing passage of a fastener, such as a hollow tubular, self-piercing rivet from a supply such as a carrier tape (not shown), therethrough under the action of a fastener driving plunger assembly 17 which in this embodiment is actuated by a hydraulic actuator housed integrally with hydraulic nose actuator 12.

In the input or supply feed line to the nose actuator 12 there is a relief valve 14, which can be set to any desired pressure and a pressure transducer 15 to give an electrical read-out of the fluid pressure within the line, thus providing a nose position and force application control for the nose drive.

In operation, the solenoid valve 13 is switched to a condition allowing high pressure fluid into the hydraulic cylinder 12, thereby moving the nose assembly 11 down towards a die 16.

Once the movement of the nose assembly 11 is arrested upon workpiece contact (not shown), the pressure of the fluid rises until it reaches the pressure set by the relief valve 14.

Thus the setting of the relief valve 14 determines the clamping force, and its setting can be programmed to provide a required clamping force profile.

Similarly, if the clamping force required differs from one fastening point to another, this can be achieved simply by varying the setting of the relief valve 14.

The nose 11 can be programmed to move to the workpiece (not shown) to monitor its thickness prior to actuation of a main fastener drive plunger 17.

However with this embodiment, using a single-action cylinder configuration, the upward or retraction movement of the nose assembly 11 is dependent upon the movement of the main plunger 17.

This limitation may be obviated by incorporating a double-action cylinder into the applicator, as shown in Figure. For ease of reference, common references are used for corresponding items in the embodiments of Figures 1 and 2.

Referring to Figure 2, a nose assembly 11 is operated by a double-action cylinder 18, and the body of the nose cylinder 18 is secured to the 'C'- frame 20 of the applicator, so that the movement of the nose assembly 11 is totally independent of the movement of the fastener drive plunger assembly 17.

Charging the upper end of the cylinder 18 with fluid causes the nose assembly 11 to move downwards towards the workpiece. When it reaches the workpiece, its movement is arrested and the pressure in the cylinder 18 rises until it reaches the level which actuates the relief valve 14.

The setting of the relief valve 14 can be programmed to provide any required pressure profile during the fastener application cycle.

By monitoring the pressure rise in the fluid circuit, for example with a pressure transducer, the moment when the nose travel is arrested can be detected.

Similarly, by interrogating a linear transducer 19, it can be determined whether the nose assembly 11 has been arrested at the correct distance from the die 16, i.e. whether the workpiece (not shown) which is restraining the nose assembly 11 is dimensionally within tolerance.

If the nose travel is correct, the main fastener drive plunger assembly 17 can safely be actuated, to apply a fastener (not shown) to the workpiece (not shown).

Immediately a fastener has been applied, the fastener drive plunger 17 is retracted, whereupon, by supplying fluid to the bottom of the cylinder 18, the nose assembly 11 can be retracted with the fastener drive plunger 17, until it is clear of the workpiece - so that the applicator is free to move to the next fastening position.

This system provides various significant advantages, specifically:

(a) a means of generating any required nose clamping force and of generating, as a fastener is applied, eg inserted, any required force profile - simply by controlling the fluid pressure applied to the nose drive cylinder;

(b) a means of applying different clamping forces at the various fastening points, by programming the fluid pressure applied to the nose drive cylinder;

(c) a means of holding the nose assembly in a retracted position at any desired point in the operating cycle.

This is advantageous when access to a fastening point on a workpiece assembly requires maximum clearance between the nose and the die of the applicator.

It is also often advantageous to hold the nose assembly in a retracted position

at the beginning of the return stroke of the main fastener drive plunger - so that the nose assembly moves away from the workpiece simultaneously with the fastener drive plunger - thereby allowing the applicator to move to its next fastening position, with minimal delay;

(d) a means whereby any monitoring operation can be completed before the main fastener drive plunger is triggered.

The fluid circuit operating the nose assembly can be actuated independently of the main fastener drive plunger, to bring the nose assembly into contact with the workpiece.

The monitoring operation may simply consist of interrogating a linear transducer to determine the position of the nose assembly, when the pressure transducer in the fluid circuit supplying the nose assembly signals that the line pressure has reached a predetermined level.

Although an example of hydraulic fluid actuation has been described, the invention admits of pneumatic implementation.

The hydraulic nose fastener applicator disclosed herein may be used in conjunction with a compensated balance mounting such is described in our pending UK patent application no. 9215265.1.

Such a mounting accommodates positional and orientational adjustment with respect to a workpiece to which a fastener is to be applied, and includes compensator means for applying compensating forces and turning moments counteracting the effects of the applicator mounted weight, by bringing the attendant mounting forces and turning moments into either equilibrium, or a predetermined directional bias, before workpiece contact, whereby, upon encountering a workpiece, ultimate adjustment of the applicator position and orientation can be dictated by the workpiece position and orientation, with minimal exertion thereupon and thereby with minimal contact damage thereto.

Claims

1.

A fastener applicator comprising

a nose (11)

movable by nose drive means (12, 18)

to contact a workpiece to which fasteners are to be applied,

a plunger (17)

movable independently of the nose drive means

by plunger drive means (17),

to apply a fastener to the workpiece through the nose

and nose control means (14) for the nose drive means

to bring the nose into workpiece contact

and to control the contact forces applied by the nose to the workpiece.

2.

A fastener applicator, as claimed in Claim 1,

wherein the nose drive means comprises

a dedicated fluid actuator

and wherein the nose control means comprises a fluid pressure relief valve

operable to control the actuator working pressure.

3.

A fastener applicator, as claimed in Claim 2,

incorporating a double-action reciprocating piston-in-cylinder fluid actuator for the nose drive,

whereby both the workpiece contact operational stroke

and the successive retraction stroke
may be implemented independently of the plunger drive means.

4.
A fastener applicator, as claimed in any of the preceding claims,
wherein the nose drive means and plunger drive means
comprise piston-in-cylinder fluid actuators
co-operatively disposed in an integral housing.

5.
A fastener applicator, as claimed in any of the preceding claims
in co-operative combination with
a compensated balance mounting
which accommodates positional and orientational adjustment
with respect to a workpiece to which a fastener is to be applied,
including compensator means for applying compensating forces and turning moments
counteracting the effects of the applicator mounted weight,
by bringing the attendant mounting forces and turning moments
into either equilibrium,
or a predetermined directional bias,
before workpiece contact,
whereby, upon encountering a workpiece,
ultimate adjustment of the applicator position and orientation
can be dictated by the workpiece position and orientation,
with minimal exertion thereupon and thereby with minimal contact damage thereto.

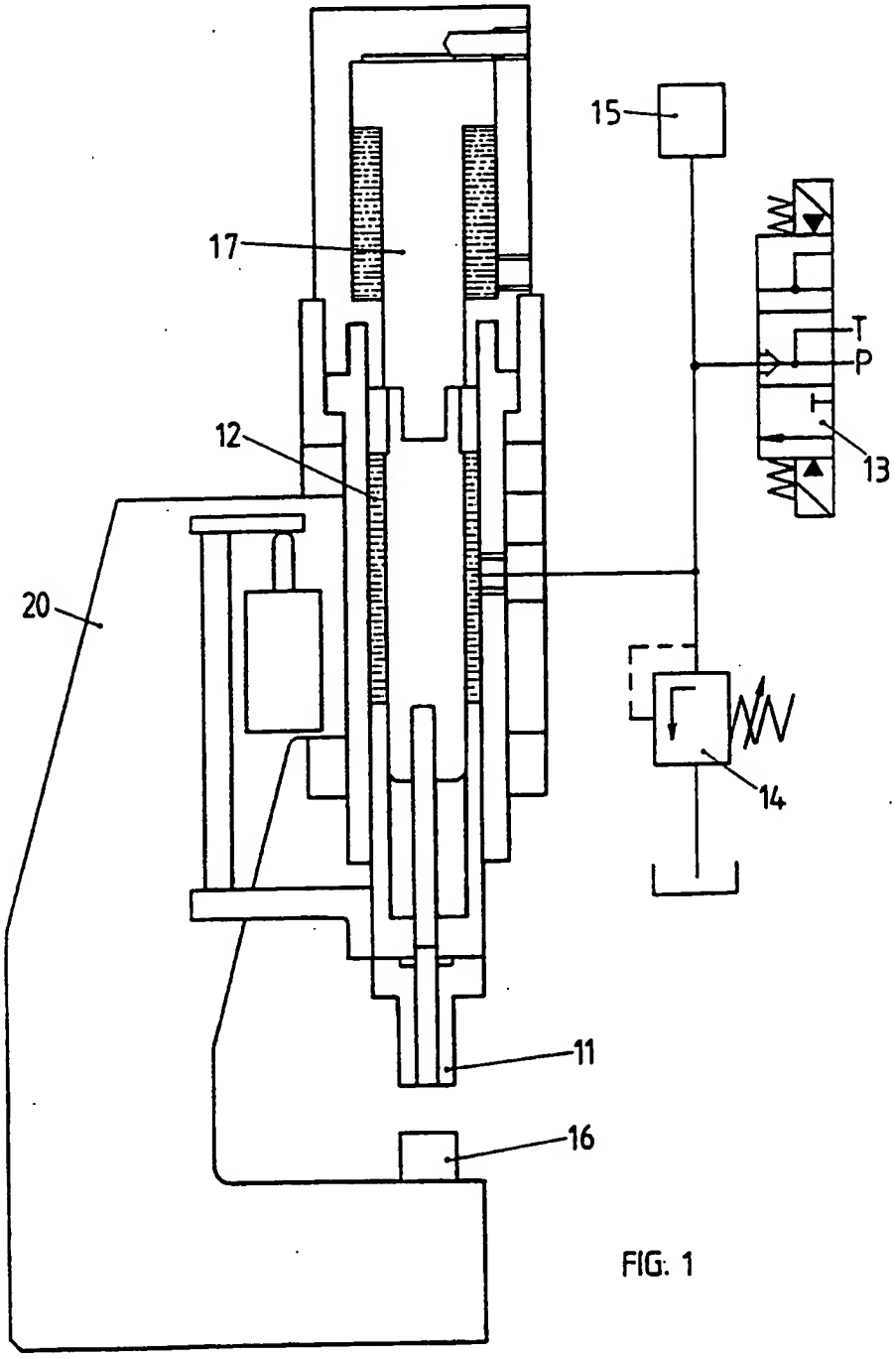

FIG. 1

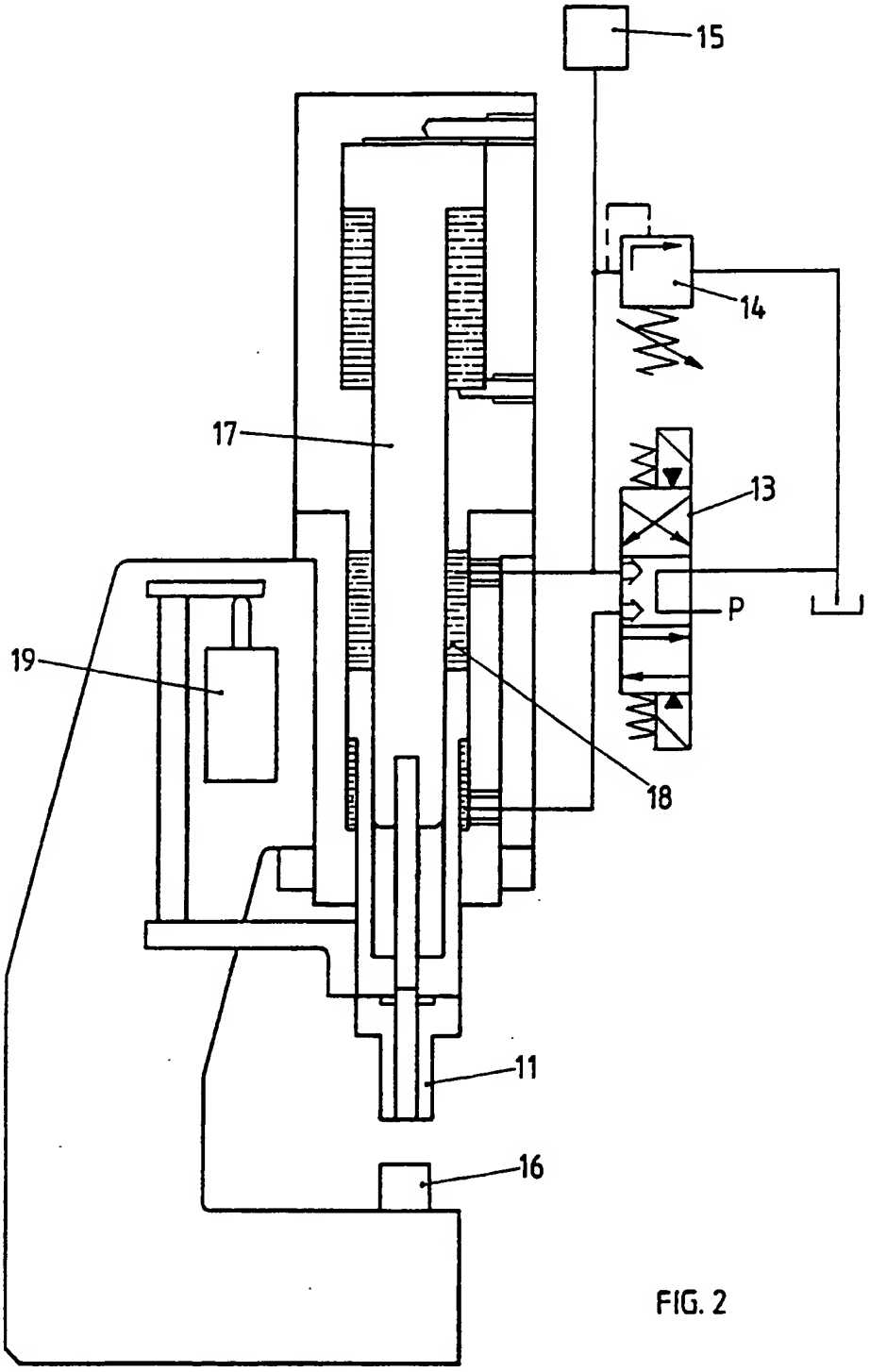

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/01140

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B21J15/28; B21J15/10; B21J15/20

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B21J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	FR,A,2 350 901 (GARGAILLO) 9 December 1977	1,2,4
A	see page 3, line 20 - line 27; claims 1,5; figures	3

X	US,A,4 096 727 (GARGAILLO) 27 June 1978	1,24
A	see column 2, line 45 - column 3, line 68; figures 1-4	3

A	US,A,5 060 362 (BIRKE ET AL) 29 October 1991 see column 5, line 39 - column 6, line 17 see column 9, line 45 - column 10, line 45; figures 10A,10B	1-5

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14 SEPTEMBER 1993	06. 10. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	BARROW J.

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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/01140

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	EP,A,0 344 906 (GEMCOR ENGINEERING CORP.) 6 December 1989 see column 5, line 53 - column 6, line 29 see column 8, line 13 - line 29; figure 1	1-4
A	US,A,4 999 896 (MANGUS ET AL) 19 March 1991 see abstract; figures 4A,7-9	5
A	US,A,4 192 058 (FALCIONI) 11 March 1980	-

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9301140 SA 74869

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 14/09/93
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FR-A-2350901	09-12-77	None		
US-A-4096727	27-06-78	None		
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		FR-A-	2664521	17-01-92
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		FR-A-	2632230	08-12-89
US-A-4999896	19-03-91	None		
US-A-4192058	11-03-80	None		